Concept for Frequency-Dependent Light Separation via Induced Rotational Scattering and Channeling

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Introduction

Although opto-electronic sensors of exquisite resolution exist and leave relatively little room for improvement, the ability to generate images of great color contrast and low noise, particularly in the context of orbital platforms, remains an ongoing matter of interest.

Abstract

Atmospheric scattering effects, importantly, both distort the angular momentum and frequency of light and can conditionally act as a light filter which causes multiple frequencies of light to be periodically, as in the case of atmospheric turbulence, diminished and even eliminated depending upon the condition of the atmosphere at the time of image capture.

Images which capture a broad spectrum of light are less prone to degradation in quality as a result of these distortions, as are images which are confined to the infrared spectrum which are, necessarily, less prone to scattering. Some specific applications for orbital infrared imaging call for monitoring for specific frequency profiles which are difficult to quantify given the scattering effects associated with atmospheric turbulence.

Opto-electronic sensors designed to detect only specific frequencies of light offer greater contrast and sensitivity than conventional sensors. In order for an orbital platform to be cost-effective, however, it must be capable of capturing a wide range of frequencies.

In order to have the best of both worlds, one might physically separate the various frequencies of light captured using a structurally variant crystalline medium with a vortex-like structure designed to alter the angular momentum of light to a greater degree depending upon its intrinsic frequency. To be clear, this structure would not be designed to alter the frequency of light, but rather, to alter its angular momentum to an extent which is greater the greater is the frequency.

In such a mechanism, light of each individual frequency could be caused to arrive at the sensor at a different time and the mode of capture of the sensor could be programmed so as to be optimized for each possible frequency at a different point in time in the image capture process. For example, the lowest frequencies of light would arrive at the sensor first and the highest frequencies last as a result of the circuitous pathway which light is forced to take through the mechanism.

If one visualizes the mechanism as a very long coiled fiber-optic wire, one can understand how it is that a sufficiently long wire could enable a sufficient

delay in the conveyance of the light to enable each individual frequency to arrive at the sensor at a different time. Because the mechanism does not consist of a wire but rather a semi-transparent crystalline structure, spatially faithful image capture may be facilitated whilst continuing to facilitate the light-delay functionality.

In a thickness of about an inch, light can be made to pass through the equivalent of about 38 miles of fiber (at the high end of the frequency range) and can therefore generate an induced hysteresis consistent with light which has traveled such a distance. This enables the signal processor to concern itself only with only one component frequency at a time and allows for maximal contrast without fundamentally modifying the opto-electronic sensor component to any great extent.

The signal processing software, however, would have to be entirely re-worked in order to facilitate such a mode of function.

Conclusion

This approach to image capture could also allow for effective resolution to be further enhanced and for sensor noise to be reduced.